THE PROCEEDINGS
of
THE INSTITUTION OF PRODUCTION ENGINEERS

The Official Journal of the Institution of Production Engineers

Members are requested to correspond with the Editor upon matters of general interest. Letters may take the form of descriptions of unusual plant or tools, workshop methods, production problems or organisation systems. Only in exceptional circumstances will proprietary articles be dealt with editorially. Manufacturers wishing to draw the attention of the Institution to the merits of their products are invited to use the advertisement columns of this Journal. All correspondence should be addressed to the General Secretary, Institution of Production Engineers, 40, Great James Street, Bedford Row, London, W.C.1.

VOL. IX. SESSION 1929-30. No. 9.

THE RELATION OF MONETARY POLICY TO PRODUCTION.

Abstract of Address given to the Institution, London Section, at a Joint Meeting with the Institution of Automobile Engineers, 20th March, 1930, by R. G. Hawtrey.

PRODUCTION is carried on with a view to exchange. When people work for money, their ultimate aim is to obtain the things that money will buy. Money is a mere token or medium. Nevertheless the immediate motive of economic activity is money, and anything which affects the supply of money reacts upon economic activity. The "supply of money" for this purpose means the daily (or monthly or yearly) amount of money that is being spent by consumers on goods of all kinds—the "consumers' outlay." The consumers' outlay is what is spent out of the "consumers' income." It includes outlay upon investments, i.e., savings, and accordingly it is true (except over short periods) that the consumers' income and outlay are equal.

In any industry the sum available to furnish the incomes of everyone concerned consists of the outlay on its product, the proceeds of

sale. The whole of the proceeds of sale go to provide incomes—wages and salaries, interest, rent, profit. The prosperity of a particular industry depends upon the outlay on its product being maintained. If the outlay dwindles, i.e., demand falls off, there is less available for the incomes of those engaged in it. Profits are less, and employment is less, or profits and employment can only be maintained by a reduction of wages. Adversity of that kind may occur without any monetary cause. There may be a transference of demand to other products. But suppose that something occurs to diminish the consumers' income as a whole. Consumers' outlay will also fall off, and all industries will find demand diminishing. Similarly, if consumers' income and outlay increase, all industries find demand increasing.

It is with such changes in the consumers' income and outlay that monetary policy is concerned. If we approach the subject from the standpoint of the stock of money, we employ the well-known "quantity theory" of money. The consumers' income is proportional to the quantity of money in circulation and to its "velocity of circulation." For this purpose "money" must be taken to include substitutes for money, i.e., bank credit. But the quantity theory itself tells us nothing of the causes which affect velocity, and little of those which affect the quantity of money.

Under modern conditions bank credit is the most important part of money, and money both comes into being and is extinguished in the form of bank credit. Banks determine the amount of credit they can create by reference to their cash reserves. But under the Central Bank system which exists in this and most other highly developed countries, the "cash" of the joint stock banks is simply the obligations of the Central Bank, viz., the Bank of England. By extending or restricting those obligations, the Bank of England can induce the joint stock banks in turn to extend or restrict credit. By their action the consumers' income and outlay are expanded or contracted, and producers find demand expanding or contracting. The action of the Bank of England is governed by the gold standard. If the consumers' income and outlay are too great, there result excessive purchases of imports and an unfavourable exchange. Credit has to be restricted till these purchases are reduced to the equilibrium point. But that means a restriction of demand for products of all kinds, a falling price level, a general trade depression, and unemployment.

The most important benefit that monetary policy can confer on production is the avoidance of contingencies of this kind. They arise for the most part (though not exclusively) from causes affecting the purchasing power of gold in world markets. That is a matter of international concern, and international action in some form is required. If value in terms of wealth can be stabilised, the need for expanding and contracting credit in any country to keep pace with its variations is eliminated.

Discussion.

MR. R. H. HUTCHINSON : I think the author is to be congratulated on his courage in coming here to express such views to a body of engineers. No doubt he is depending upon the belief that engineers are most uncommercial people. I have heard it said that to be a good engineer you cannot be commercial. What appears to me to be a very important point arising out of the lecture is that the real relation between money and industry to-day is the amount of actual production which is paid for, by the money expended, as against consumption. We know that although the income and expenditure of the community must be the total money circulated within it, production is not necessarily equal to the total expenditure and it can only be when production *and* consumption are high that we are well off. If production is low, no matter how much money is circulated, we cannot be well off, so that it seems to me that the whole question comes down more to a matter of the production of raw material and the necessaries of life rather than the mere circulation of money. Is it not the rate at which the raw material is produced, as raw material, and is consumed as finished products at the other end that really governs the prosperity of a community or the world.

As a simple example let us take the case of a motor car. A motor car is produced, money is paid to the manufacturer for the car and there the matter ends so far as it concerns the prosperity of the nation in relation to the production of raw material. It does not matter how many times that motor car is sold, or re-sold, that does not help the motor industry. It is only when a new car is produced that you really get any more money into the industry. I think that illustrates my meaning, that it is only when raw material is produced and consumed that the community benefits. It is quite true, of course, that the existence of an old motor car is useful in consuming petrol, oil, tyres, etc., but again all these commodities are raw material and so we come back to the original point that it is only by an increase in the consumption of raw material and an increase in production that is really of use in creating prosperity, and that money is merely a means or a token which enables that to be done. The author referred to the fact that the economic motive is money, but I cannot quite agree with that. I think the economic motive must be what money stands for. I cannot help feeling that what the world is suffering from to-day, especially the industrial nations of the world, is that the number of non-producers has gone up to a point where it outweighs the number of producers. We have an ever increasing staff of travellers, salesmen, clerks, and so on, with the result that the non-productive end absorbs too large a proportion of the proceeds of industry as compared with the productive end and thereby their purchasing power is impaired, and this may possibly account for the ill from which industry is suffering which to my mind is much more a

matter of under consumption rather than one of over-production. It is, of course, only a matter of balance as between the two bodies since a correct proportion of non-producers is as necessary to industry as the producers, not only for the purpose of running industry but as consumers of production. Perhaps we shall in time get the swing of the pendulum and people will gradually be attracted back to the ranks of the producers. Is it not possible that this is the crux of the industrial situation to-day almost throughout the whole world ?

THE AUTHOR : I do not think there is any magic in raw material as such. Eventually productive capacity depends upon the due circulation of money. In practice producers regulate their activities by the demand and the amount of the consumers' demand is regulated in the manner I described in my lecture, namely, by the consumers' income. If there is unemployment the production falls off and we are worse off and there is the danger of an accumulation of unsaleable products, a situation which exists in so many raw material markets to-day. I am not at all sure that many of the classes of people whom Mr. Hutchinson referred to as non-producers are really non-producers. They may in many cases be most useful producers. I do not know, for instance, how you would class school teachers. They produce no material product but they are the most important producers in the country and the cheapest, having regard to the value of their work. In the same way it is not at all so certain, as Mr. Hutchinson would apparently have us believe, that clerks and salesmen are non-producers, because however many goods you may produce, they are absolutely valueless until they have been brought to the consumer who wants them. If you produce a motor car and nobody wants it, it is absolutely waste so that the function of the men who can find a purchaser is of the utmost importance to the actual producers if their work is to be worth anything at all.

MR. ROLLINGS : The most important point that arises from the lecture, in my opinion, is the power of the banks to regulate the credit of the country, which, of course, is the controlling factor in financing the production of materials from the initial stages until they reach the consumer's hands in a finished form ; there is little doubt that the credit which banks are able to create or destroy has direct effect on production. I have often wondered what policy dictates the alteration of credit. I have read in several books on economics that the governors of the Bank of England look forward and try more or less to postulate the monetary conditions six months ahead and so dictate their credit policy. Some economists agree with that but some do not. There is a school of thought that the amount of credit created depends on the gold or cash reserves in the country, but there seems to me no necessity to have any particular relationship between the amount of credit in the country and the gold reserve. The main reason for keeping a gold reserve in the

country is to permit of the withdrawal of gold in order to balance the exchanges, and if a common policy could be arranged between bankers for this adjustment, other than upon a gold basis, it would permit an extension of credit, to be placed upon a more elastic basis, and it is very probable that a formula could be arrived at that could determine the amount of fiduciary issue or credit available based upon the average consumption requirements of a population, taking into account that a certain amount of luxury spending should be included in these requirements.

MR. MOYLAND: I wish the author had devoted more time to the actual monetary system of to-day as it affects industry. There is this fundamental and most vital defect from the point of view of ordinary industry in the present monetary system, namely, that a revival of industry, to which we all look forward as our only hope and salvation, automatically throttles itself. Periods of trade prosperity are inevitably followed by periods of trade depression and our monetary system gives a very clear indication of the cause of that, namely, that the money on which industry depends for its functioning is regulated by the banks to form a due proportion of the amount of gold that happens to be in the country. The gold standard really does not affect it very much. The whole of our monetary system is based on the very slender quantity of gold which is being fought for by the various nations of the world to support their own industries and credit. If we have a trade revival here it is invariably accompanied by an increase of credit but the banks can only increase that credit beyond a certain point if they happen to get more gold. If they cannot get more gold from somewhere they have to fight with the other countries for the available supply and the controlling factor in that is the bank rate. The bank rate is raised in this country in order to make it profitable for other people to send gold here and it is in this way that you have an automatic throttle on any real increase of industrial prosperity in this country instead of being able to increase our prosperity according to our means of production.

THE AUTHOR: I am bound to say that Mr. Moyland's speech is thoroughly sound and convincing for the most part, but there is one point I should like to comment upon in relation to his reference to the extreme inelasticity of our monetary system. Personally I do not think it is quite so inelastic as he suggested. Indeed, subject to a certain limitation we have a complete elasticity of our monetary system and indeed in more recent times have introduced an element of elasticity which was formerly absent from it.

Replying to a comment by Mr. Norman Wyld dealing with the same subject,

THE AUTHOR said: I adhere to my view that the Bank of England can, subject to certain limitations, do all that is required. The reason is that the Bank of England regulates the credit system

which finances international trade all over the world. If a Bill on London commands a more favourable rate—as it does to-day more than at any other time during the past 7 years—that tends to encourage merchants engaged in international trade all over the world to enter into commitments. He knows, if he orders goods from any one country to be sold in any other, that that transaction can be financed on easier terms and he is slightly more ready to do it, and it is in this respect that cheap money in London stimulates enterprise all over the world and of course, a Bill in the London discount market is essentially an instrument for international trade.

MR. GERARD SMITH : I think many of us are completely at sea to-night in the economic problems that have been discussed and there is one point which I understand even less than the others, upon which I would like the views of the author. This country has had an adverse trade balance for a good many years. We are spending more than we are receiving and I would like to know which of the two things is happening. Are we producing wealth to a greater amount than the capital we have and so keeping our heads above water, or are we continually getting poorer and poorer by the export of money to pay for the goods which we cannot pay for by our own manufactures and exports ?

THE AUTHOR : That problem is soluble in terms of what are called invisible exports. If you examine our balance of trade as expounded in the Board of Trade Journal you will find that last year, although there was an excess of imports over exports of £350,000,000 we are receiving interest from abroad to the extent of £285,000,000 and were also earning £65,000,000 on bank commissions, mercantile commissions, profits of insurance companies and that kind of business, and £130,000,000 simply by the activities of our shipping, and as a result of all this we had a favourable balance of £151,000,000, and we are investing that amount abroad. As a matter of fact, there has been no year in living memory when we have not been investing abroad. There was one year—I believe the year of the last coal strike—when according to the first calculations there was a small adverse balance but on checking the figures it was found that there was a small balance on the right side.

MR. GERARD SMITH : That is the best news I have had for a long time.

MR. A. J. HANCOCK, President, London Section, after congratulating the speaker upon his lecture on a vital, but little understood subject, said :—It seems to me that the author has *described* our monetary system but has not attempted to *discuss* it. I think I am entitled to take the view from what we have heard to-night, however, that our monetary system places in the hands of the banks an enormous power, it would seem almost a malevolent power, because what they do seems to be primarily in the interest of the monetary system rather than of the industrial system. It seems to me to be

a " money commodity " policy and not an economic policy. Many of the phrases used by the author in describing the system, if I may say so, do not seem quite to fit the realities of life. One hears of " consumers' demand " but I think " demand " is the wrong word. What one should say is that consumption does not balance the consumers' *desires* because we have on the one hand a limited demand with almost unlimited desires : on the other hand, we have producers of almost unlimited capacity to produce. We have here to-night a large number of production engineers whom I would call very repressed production engineers. I do not think they are producing all they would desire to do although there would be no difficulty in selling all that the production engineer can produce if the purchasing power of the consumer existed. What limits the purchasing power of the consumer ?—for it is evident that consumers have not the power to purchase their own products. The desires of the purchaser are unlimited and we have a whole army of eager and even frantic people trying to persuade consumers that they ought to buy various goods but the simple fact is that the consumers have not the purchasing capacity to buy what they really want. In short, the position is that the consumers are under-consuming, notwithstanding that they have a very great desire to consume, and Mr. Hawtrey's remarks leave in my mind the impression that the present monetary system is the restraining influence.

THE AUTHOR : I hope you will not think that I appear as a defender of the monetary system as it has been working. In fact, one of the principal purposes of my lecture was to bring out the fact that this monetary system can produce a shortage of demand, whereas a monetary system adjusted to circumstances would be found to be an advantage. The conditions a short time ago led to the bank rate being increased to $5\frac{1}{2}$ and $6\frac{1}{2}$ per cent. and the effect was to intensify the shortage of consumers' income and outlay, not only in this country but all over the world wherever markets have been flagging. It has become more and more difficult to sell because of the shortage in purchasing power. I think that credit should be so managed as to avoid any arbitrary contraction or expansion in consumers' income and outlay. The effect of that was well exemplified in the experience of the United States in the period from 1921 till 1928/29, when they started measures of credit contraction in order to stop the rush of speculation on the stock market. During that interval difficulties hardly existed. There were transitory experiences of depression and unemployment, but they were so short and slight that the country really did not suffer from them. The secret was that they stabilised their currency, and I believe the same thing could have been done through the instrumentality of the Bank of England for practically the whole of the civilised world. I believe that by similar steps the evils that have been described could have been avoided, but only experience can show whether that

is absolutely right. Personally, however, I am confident about it, particularly after the experience in the United States.

MR. BIDDULPH: I should like to ask the author's opinion as to the difference between the real rate of interest and the Bank rate? Secondly, does he agree with Professor Cassel that money circulated in stock market speculation does not affect the level of commodity prices? Thirdly, what effect has our foreign investment in producing an unfavourable sterling exchange? And finally, what is the effect of saving upon the adequacy of purchasing-power, the theory put forward by Dr. Hudson Hastings, in *Costs & Profits*.

THE AUTHOR: There are several different real rates of interest. There is an underlying long-term rate of interest at any time which represents the actual yield on fresh investment in those openings that are available at the moment. Then there is a short term rate of interest which is modified by the rise or fall in prices which affect the future value of currency in which the loan is calculated. In other words, if prices are rising it is worth while paying a higher rate of interest as an insurance against a loss of value of currency. With regard to the effect of foreign investments, the general position there, I think, is that the country which is investing abroad has less favourable conditions at home. Perhaps the best way to put it is that if you wish to invest capital abroad you have to send it somehow or other in the form of goods and then it is necessary for your consumers to be reduced so that they will consume less imports and so affect the balance of payments and enable you to have a credit balance. That, however, only occurs when there is a change in the country investing abroad. We have been investing £150,000,000 a year abroad for some time and so there is no arbitrary change involved there, although, as a matter of fact, if you can introduce any device which reduces your lending abroad, it may have a favourable effect upon your price level and enable you to expand your consumers outlay a little more. With regard to the theory put forward by Dr. Hudson Hastings, mentioned by the last speaker, I am afraid I have not seen his recent writings. With regard to the effect of speculation on the Stock Exchange upon the level of commodity prices, if there is an increase in consumers' income and outlay it may cause a substantial disturbance of equilibrium, especially if industry is employed to capacity at the time. It may have the effect of causing an undesirable feverish boom in industry quite apart from the actual stock market speculation.

On the motion of the Chairman, a very cordial vote of thanks was passed to the author for his lecture and replies to the discussion,

THE RELATION OF PRODUCTION TO CONSUMPTION.

President's address to the London Section, 3rd April, 1930, by A. J. Hancock, M.I.A.E., Section President.

THE title "Presidential Address" implies or carries with it an idea of dignity, formality and oratory eloquence to which I fear I am unable to do justice and that my remarks will not rise above the level of simple conversation which I hope will be prolonged in subsequent discussion, during which perhaps a suitable title will emerge.

In conformity with the practice of contemporaries and predecessors I must refer first to our Institution. I think the time is past for explanation of its aims and objects and justification for its existence which run almost to the length of excuse. Our Institution to-day is so solidly founded, so well supported, and so warmly welcomed in newly formed centres that it would be presumptuous to attempt further justification.

This condition has not been accidental or fortuitous, as indeed no specialised community can ever come into existence accidentally or fortuitously. You have been well served by men of energy, insight, technique, knowledge and perseverance and I cannot pass over this phase of my conversation without reference to one or two of the many strong personalities whose individuality has been impressed upon this Institution.

I believe I shall be offending none and expressing the view of most when I refer to my predecessor Mr. Hutchinson as almost the founder of our Institution as we find it to-day and whose continuous activity is carrying it forward from strength to strength.

I can imagine no more suitable man than Mr. Hazleton for filling the important office of General Secretary, reinforcing the development work initiated by your Development Committee; one whose general capacity is clearly capable of handling the affairs of the Institution when it shall have grown to many times its present size and strength. My only criticism of him is that he should so patiently submit to office quarters that we ought quickly to show we have outgrown.*

In supporters of the Institution you have a list of well-known men of standing in the engineering world, and in your Proceedings you find the work of such outstanding men as Mr. L. H. Pomeroy, who is

*The Offices were moved two months later (June, 1930) from 48, Rupert Street, W.1., to 40, Great James Street, W.C.1.—Editor.

not only a man of standing, but a man of vigorous, inspiring and effective action in the realms served by this Institution.

For the advantages arising from the work of such men you have every reason for satisfaction.

Turning to the current session of the London Section of the Institution, one is impressed by the character and quality of the papers, lectures, and discussions that have taken place and the evidence that they have shown of the quality and effectiveness of your members' work in the field of daily production life. If I may comment, I feel that whether intended or not the actual work of the Institution is steadily justifying the definition given by Mr. Pomeroy upon two occasions, namely "To promote the science and practice of production as applied to Engineering." I incline towards that definition as a more accurate description of what, in fact, is going on, and should continue, even though at variance with the present stated "Aims and Objects," the boundaries of which seem to extend into nebula.

Leaving the safer realms of favourable comment upon the work of the Institution I shall—with some heresy—presume next to comment upon the very foundation of a specialised Institution, namely "Specialisation in its particular technique."

I know I shall be told that this is the epoch of specialisation within a particular technique; that he who does not specialise to the exclusion of all else, is lost. Well, it may be so, but I shall endeavour to arouse other views, for I believe a warning note wholesome at this stage in our Institution's development. I shall suggest to you that the work and Proceedings of this Institution can become over-specialised in its particular technique to the exclusion of allied—but nevertheless fundamental—problems, until perspective becomes distorted and the relationship between your art and life becomes confused or out of focus.

I once heard a very humorous American address an audience upon the process of Specialisation, and he proceeded to show that the specialist was learning more and more about less and less, and the generalist was learning less and less about more and more until, by logical progression, he visualised that ultimately one half of a community would know everything about nothing, and the other half would know nothing about everything.

This disaster is unlikely to overtake men of our nationality because, not being specialists at heart, we are unlikely to precipitate or segregate into such sharply defined schools of "knowledge," but there is a danger of becoming so obsessed with "Speeds and Feeds," "Floor to Floor," "Production Flow," and of the many potted phrases which make up the borrowed terminology of your science, that we may forget what it is all for, we may forget *why* we do these things, in effect, we may forget that these activities are not ends in themselves, but only one of the means to an end, and that

the end to which our technique is but one means, should be constantly tincturing and moulding the fabric of our technique, lest we stand alone in our narrow specialised perfection, out of tune with the generalities of real life.

It may seem foolish to suggest one should look within the Institution of Production Engineers for the interchange of ideas on any subject outside the specialised one of production, but I feel that one of the most interesting and instructive papers or lectures of the session was given by Mr. R. G. Hawtrey on "Monetary Policy," and although it had very little to do with the science of Production, yet, in my judgment, it was one which should have been attended by every production engineer, not in his specialised capacity alone, but in that broad generalised capacity to which I have referred, and without which his speciality is nothing.

The inclusion of that lecture, so ably given by an eminent man, bears eloquent testimony to the breadth of view and wisdom of those compiling your syllabus, and its inclusion in this session seems to make my earlier remarks redundant, but those remarks are justified because the attendance at that lecture clearly indicated that the average production man reasoned that—being a production specialist—he was not interested in generalities outside his speciality.

For this reason I have ventured upon the gentle warning of the dangers of narrow and concentrated specialisation. Mr. Hawtrey's lecture stimulated thought, and, through the medium of the production engineer's mind a key might be found to the production engineer's main problem to-day, which problem I shall suggest is not only one of production at all but one of consumption.

I have heard it suggested that the basis of a country's prosperity is its production and thus by an easy play of imagination the production engineer falls naturally and gracefully into a comfortable rôle as the author of a country's well being. At first sight this appears logical because the more that is produced, the more there is to consume and enjoy; but what are we to say concerning a country in which a great portion of its production energy is lying either completely idle or producing far below its capacity? Surely the production engineer is already ahead of the game.

Let us examine this outrageous suggestion a little more closely, considering it broadly and not in the one or two temporarily bright spots. It is a question of fact that our production resources are capable of yielding far more than they are in fact yielding to-day by merely employing them all, and employing them to capacity. It is also a fact that production engineers are striving, by their skill, to produce still more from these resources that *are* active. It is a further fact that a large army of people is engaged—indeed one might say frantically struggling—in advertising, canvassing and in operating all the mechanisms of processes allied thereto for stimulating a laggard consumption.

Can it be that our consumers do not want the increasing production arising from your efforts? Can it be that our consumers do not really want even the production now being accomplished? Surely not, for that would be to deny the existence of established human behaviour.

How then, can we explain what is evidently a restraint or repression of the production engineer's craft or science? Restraint of that which is suggested as the fount and origin of a country's prosperity? Here indeed is food for thought by all, production engineers included, and it is along such a line of thought that I hope to provoke conversation and discussion. Doubtless I shall be told that this is not a problem for production engineers but for another branch of human activity, and I am suggesting to you that production engineers cannot stand in specialised perfection aloof from the greater problems of life upon which alone their very specialisation depends.

I have not a ready-made explanation to propose, and out of the authority vested in me as your President, I am going to reverse the usual order of things, and to ask you questions instead of you asking me questions, in order, as I hope, to stimulate thought upon a paradoxical situation.

Has not the production engineer now to consider the "consumption engineer" and the reason why he consumes or refrains from consumption? It seems idle to suggest a country will become more prosperous by greater production, until the whole of its present production is being freely consumed.

I am reminded here of the old, old story of the Works Department versus the Sales Department in any manufacturing concern. We know that the Works Department, in its capacity to produce, can always outrun the Sales Department in its capacity to sell (and incidentally it is an easy task). What, in my opinion, we have not so readilly realised is that the Sales Department in its capacity to *sell* quickly outruns the consumers' capacity to *buy*.

What the Sales Department *senses* is that "Demand has fallen off," but reverting to our earlier thought, this is only another way of saying to the production engineer "Apparently your goods are not needed, you must cease production, you must be repressed. This 'prosperity' you are trying to foist upon us by your art is not wanted."

Here is a paradox indeed, and I am saying to you that repressed you are, and will remain, until the key is found to the problem of consumption.

I have used the phrase "Demand has fallen off." What does this mean? Does it mean that people are so saturated with goods that they do not even wish for more or better goods? Surely not—reflect upon what I have referred to as "established human behaviour" and we find that, notwithstanding a cessation of "de-

mand," there remains and continues a wish to possess, use, or consume the goods that are producible by your art.

As you go about your daily life, what do you find? In any workshop an urgent desire for new and better machines, appliances and apparatus. In any office a desire for new and better furniture, equipment, accessories. In any home, club, institution or association, a desire for new, better and more motor cars, utensils, warming and cooking apparatus, and so on and so forth.

These people are all rich in desires but yet if you go into the workshops producing all these delightful goods for satisfying those human desires you will find them working short time. You will learn that the "Demand has fallen off." This can only mean that "commercial demand" and "human desire" are not the same thing, and that the limitations of demand are not the limitations of desire. What then limits demand if desire does not? Clearly purchasing power. And what limits purchasing power? Here we must inquire of Mr. Hawtrey's "Monetary Policy" to explain the discrepancy that exists between these two and I ask you whether, not perhaps an answer to, but at least consideration of, that quest is not vital to your existence and progress, and whether in importance it does not transcend all questions of "cutting speeds," "Piston line efficiency," whether you have not already gone too far in setting up producing resources capable of quantities that cannot be consumed, and whether it is not appropriate for you to turn some of your attention to the restraints on consumption.

To sum up therefore may I put the following questions to you, not because I expect a complete answer, but because I hope to have stimulated your interest in the problems they imply :—

1. Is not the production engineer suffering from restraint or repression?
2. Does not over-specialisation in the technique of any profession tend to blind its votaries to the general problem of life, and is not a little warning timely?
3. Is not consumption by the "consumption engineer" a general problem that needs solution before the art of the production engineer can be practised and developed to the limit of even current knowledge?
4. Does a nation's prosperity depend upon its capacity to produce or upon its capacity to consume?
5. Does not consumption depend upon purchasing power and "Monetary Policy?"
6. Am I not right in suggesting that demand falls off before human desire is satiated?

I submit that these questions merit the attention of Production Engineers and I hope that the way I have put them will provoke discussion, which I shall be grateful to take part.

Discussion.

MR. GEORGE STILL said the President apparently did not consider that production was the sole function of the production engineer. He himself found, as production manager in one of the largest motor manufacturing firms in the country, that he was not allowed to forget that production was his sole duty. He had to sit round a table with the directors, the sales manager and the chief accountant, and it was impressed upon him that he was to produce exactly what the sales manager thought he could sell and at a price at which the works accountant would allow manufacture to take place, in order to make it a commercial proposition.

THE PRESIDENT replied that even though a production engineer might not be allowed to forget the fact that his primary function is to produce, he could in his leisure moments consider to what extent the production engineer is contributing towards the general well being, and to what extent he can, by engineering improvements play a part in improving the general position. Engineering production is of no value unless the products can be purchased. Statistics shewed that the combined purchasing power of the country at any one time is incapable of purchasing the combined productive capacity of the country at any one time. The object of his address was to endeavour to stimulate wonderment in the mind of the production engineer as to whether it was not time for him to reflect that before he went on producing more and more he must give some of his intelligence to the problem of what restrains people from purchasing his product when finished.

MR. H. E. WEATHERLEY said that some figures he had recently seen, if correct, would explain why we are unable to consume all the goods we produce. According to these figures the average cost of our exports was up by nearly 15% as compared with pre-war, and yet we were supposed to be able to produce more cheaply than pre-war. Again, the lack of consumption seemed to him to be due to a lack of foresight on the part of the management in assuming they could sell a product for which there was no demand or too much competition.

THE PRESIDENT replied that he did not consider the export illusion any answer to the general problem because, just as imports were bought by exports, so exports were paid for by imports, and if we had not the purchasing power to buy our own products we could not have the purchasing power to buy what comes in from other countries. Although on the face of it lack of consumption might be due to bad management, the fact that the people had not the purchasing power was an over-riding factor. It was not because people did not want the goods. Their desire for them was great but their purchasing power was insufficient.

MR STILL suggested that as the President had agreed the demand

existed, it was for the production engineer to produce more cheaply to satisfy the demand at the price which the purchasing power of the public made possible.

MR. WEATHERLEY said that if we could increase our exports by 25 per cent.. we should have no problem.

THE PRESIDENT said he could not agree to that.

MR. PIPER said he had been in Brazil some 18 months ago and his experience there suggested that some of our troubles in regard to lack of consumption of goods made in this country are due to the fact that we make such excellent machinery for producing goods that countries elsewhere are buying that machinery and producing the goods for themselves.

THE PRESIDENT said we could hardly quarrel with the process of sending machinery abroad because that was the cause of the prosperity of England from 1830 to 1890. He quarrelled with the suggestion that we could over-produce. We could only under-consume. Consumption could be stimulated and the ingenuity of the manufacturing powers and producing powers of a nation were so wide and varied that new forms of product could be developed and consumption stimulated in that way. He failed to see how the export argument affected the problem or could explain it. It was necessary to deal with the whole producing powers of the country and not with particular trades. If England did not want choppers, for example, then we must make something else. That was the fundamental idea he was putting forward. The purchasing power of a community must equal the productive capacity and whilst there were goods in stock there would always be what was called unemployment. A case in point was tiles for bathrooms and sculleries, etc. How many people would like their bathrooms tiled to the ceiling but could not afford the tiles? Yet there were tile makers out of employment and tiles in stock unconsumed. Why not introduce labour saving devices to make tiles cheaper so that the desire of the community to have these tiles could be met at the price the community could afford.

MR. C.C. FERGUSON said that surely fresh money was brought into the country by exports but at the present moment many things could be bought more cheaply in other countries than here; for instance, castings could be bought more cheaply in Belgium. The lack of consumption in this country was partly due to the fact that people would not spend their money. It was no use destroying unless the money was coming in to re-build, and it was for that reason that more money was wanted in the country from exports.

THE PRESIDENT replied that this involved the question of credit which had been so ably dealt with by Mr. Hawtrey at the previous meeting. We were, at the moment, suffering from a restriction of credit. If everybody spent all the money they had the spending power of the people would be very much nearer to absorbing the

producing power of the production engineers. That, therefore, was another question. Why did not everybody spend all the money they had? If they did it would remove the restrictions on credit and expand credit.

MR. H. S. LOCKER remarked that the real point brought forward by the President was that we have reached saturation as regards the consumption of most of our products. It has been remarked that people would not spend their money, but since the War there has been a great advertising campaign advising people to save their money and there were thousands of people saving money unnecessarily where they might be enjoying comforts and advantages by spending it.

A SPEAKER suggested that change in desire had something to do with under-consumption, so-called. The demand for an article might fall off although preparations had been made for production on a considerable scale on the anticipations of the Sales Departmant. That had been noticeable even in the case of motor cars.

MR. S. H. BAILEY said the effect of change of desire had been particularly noticeable in the wireless industry, and it had had very serious results for some firms.

THE PRESIDENT retorted that on the question of change of desire, it is only a certain favoured few who can afford to change their desires, and amongst the bulk of the community this could not be regarded as a serious factor.

MR. LOCKER pointed out that there is now a much greater volume of trade done by this country than 20 years ago and also much more money being saved than was the case 20 years ago. Trade was increasing and there was a larger number of people employed.

THE PRESIDENT agreed that in the main we have not much to complain of in this country. At the same time, the question he had put was that people are not consuming the output and an answer was required to that question.

A SPEAKER suggested that over-production had been brought about by the replacement of handicrafts by mechanical means.

MR. H. J. PING said his belief for years had been that there is no such thing as over-production but there was under-consumption. A great necessity was reduction of costs and he suggested that production engineers should ask their sales managers to reduce their distribution charges. There was great scope there for economy. If these costs were reduced then selling prices could be reduced. In 1916 the Ford motor car sold in this country for £125 but the cost was £26. Of that perhaps half represented the work of the production engineer so that an enormous proportion of the selling price went in the selling and distribution. There was plenty of scope for the reduction of costs and the consequent increase of sales.

MR. FERGUSON pointed out that the large sum of money that was being demanded by way of taxation is reducing the purchasing

capacity of the nation. Money was being taken for such things as roads, electrical development, railways and so on.

MR. LOCKER: The ultimate result of that is to provide more employment.

THE PRESIDENT pointed out that the spending of money in the way Mr. Ferguson apparently complained of had an extraordinarily cumulative effect in its results, as hinted at by the last speaker.

MR. FERGUSON said the point was that if he had £100 and £30 was taken in taxation he could not purchase so many goods.

THE PRESIDENT agreed that we cannot consume our own production and he was asking why. It seemed a paradox to him.

A SPEAKER: Would not more equal distribution of the wealth of the world improve purchasing power?

THE PRESIDENT said that did not affect the position at all, in his opinion. The taxation question was a complicated one and was really a means of forcing people to spend money.

ANOTHER SPEAKER suggested that there are unlimited markets as yet untouched in various parts of the world and surely they should be fully developed as a means of consuming our own production.

THE PRESIDENT said that might be an answer to his question, but to come back to his original point he would ask those present as to how many of them were producing to capacity and were disposing of it?

There was no response to the Chairman's invitation for information.

MR. WEATHERLEY said they might not be producing to capacity but also they were not producing to a price and it all came back to that. In that respect we were a very long way behind. In a recent case of an order for overseas our firms could not touch it on price and it went to America. The result eventually was that the British firm closed down and 1,500 people were dismissed simply because they were not producing the goods cheaply enough. He contended that our production engineers are a long way behind and the whole solution was to get the price down.

MR. BUTLER asked if it could be expected that any of those present would get up and say they were producing to capacity.

THE PRESIDENT said he did not mean his question to be too precise. What he meant was were they fully occupied, and were they disposing of all their products. If not, why? Two answers had been given to his question and the best one was that we must export more but he did not consider that was an answer.

MR. BUTLER agreed with a previous speaker that it is not so much production that is wrong as the cost of distribution. It often cost £2 to sell a £1 article. Did they get the same value for the £2 as they did for the £1.?

THE PRESIDENT agreed that this is a fact.

MR. BUTLER added that until we can reduce the very large percentage that at present has to be added to the manufacturing

cost of an article in this country, our markets would be severely restricted. It had been said that we cannot consume our own production, but how was that arrived at when we could not produce certain commodities that we really want ?

THE PRESIDENT making some final comments on the discussion said that our favourable trade balance is growing and 150 millions sterling were invested abroad. England was by no means a back number. The object of his address was to stimulate thought on this whole subject and he felt he had been successful in doing so

A cordial vote of thanks was passed to the President at the close of the discussion.

LOW-VOLTAGE ELECTRIC WELDING.

Paper presented to the Institution, Birmingham Section, 16th April, 1930, by T. F. Holden.

THE subject of to-night's lecture is low-voltage welding. I have chosen this title because the alternative title of resistance welding is open to misconstruction. This process as devised by Professor Elihu Thomson so long ago as 1881 is a very simple one. A low voltage current is passed through the junction of two pieces of metal at a heavy amperage, thus causing heat to be generated at the joint. As this reaches a temperature sufficient to cause the metal to become plastic, a heavy mechanical pressure is applied to force the metal into intimate molecular cohesion. The current is switched off and, after cooling, a practically perfect joint is the result.

Now I want you to note that the only novel feature about this process is the use of electricity to evolve heat directly in the metal, otherwise the process follows the general blacksmiths' methods of hundreds of years previously. From this simple process a large range of highly developed machines has resulted, catering for a wide variety of metal working trades.

To-night I propose to talk about the two types of machines in most general use—butt welders and spot welders. Butt welders are used mainly for the welding of bar or wire sections together or to drop forgings. These machines are in effect simple alternating current transformers fitted with heavy copper secondaries and vices. One of the vices is movable and is controlled by mechanical upsetting gear. The smaller machines, say up to a capacity of half square inch, are generally automatically controlled, the upsetting pressure being applied by means of an adjustable spring. The operation of these machines is very simple. The bar or wire is placed in the vices with the end abutting midway between the gap. The spring pressure is released. We now close the primary switch and the metal rapidly heats up. As the metal becomes plastic the movable vice gives under the upsetting pressure, forcing the plastic metal into the form of a burr around the joint. The movement of the vice at the same time trips the cut-out switch and the weld is completed.

A machine of this type is very sensitive and welds can be made in practically any metal. The machine is fitted with regulators for varying the current in steps (from one and a half volts to three volts in four steps are the usual figures) with welding times of one to three seconds, according to size and metal. These machines thus have four variable factors, the determination of which requires

a high standard of skill and knowledge supplemented by experiment. These factors are: First, distance of gap between vices; this may be from quarter inch when welding one thirty-second diameter steel wire to one inch when welding half inch diameter. Second, current voltage from one and a half volts to three volts for the same range of sizes, but also require adjustment according to the amount of upsetting pressure; a metal that requires a heavy upsetting pressure will generally require a higher voltage. Third, upsetting pressure is determined partly by the previous settings and partly by the metallurgical quality of the metal. Fourth, the amount of upset will vary according to the accuracy with which the ends abutt and the metallurgical requirements. The settings on these machines as a rule are calibrated and, once the settings have been found and tabulated for each job, can be used at a future date to obtain identical results.

The importance of making a series of welds with varying factors and testing the welds for strength cannot be over-emphasised, as sometimes a variation of a few ounces in upsetting pressure in welding small wire will make twenty-five per cent. difference in the strength of the welds. These small automatically operated machines can be used for a wide variety of wire and small rod work. They are largely used by wire drawers for joining together wire coils in copper, brass and steel, and the welds withstand the subsequent drawing operations. A very large range of work is also done by wire workers. An interesting job is the welding of nickel points to steel shanks for the centre electrodes of sparking plugs. Another rather difficult job done successfully is the welding of high carbon steel wire for wire ropes. In this case the weld is glass hard and the machines are arranged for annealing the joint immediately after welding.

Another type of butt welder in general use is the hand-operated machine for welding iron or steel up to one square inch. In principle the operation is exactly the same as the smaller machine, but the switch is operated by hand or foot, and the upsetting pressure is applied by a hand-operated toggle or cam. This has to be fairly powerful, as on some classes of work approximately one ton finishing pressure is required. The welding time varies from three to thirty seconds. Above this range the upsetting pressure requires the use of worm wheel and screw or hydraulic power. To sum up, we have in these machines practically perfect means of producing heat which can be easily regulated to a fine degree. We have means for applying upsetting pressure within a few ounces of the correct amount with perfect regularity. We have means for cutting off the current within a fraction of a second, and the amount of upset can be regulated within a few thousandths of an inch, and the strength of welds made is practically equal to the original metal. So far as the machines are concerned I consider that they are very

near the peak of their practicable development. We have electrical efficiencies up to ninety-six per cent., power factor up to .9; dozens of types of quick acting clamping mechanisms, and there are at least a hundred distinct designs of machines covering practically the whole field of present-day possibilities.

At this point you may ask, "Why, then, are these machines not in such universal use as their merits deserve?" Well, there are difficulties. The first is that of current supply. Although any kind of electric current which produces heat could be used for the purpose of welding, it is in the use of alternating current that we find the required adaptability to this special application. It is easily transformed to the required low voltage in the machine itself, regulated at a very high efficiency and at a reasonable cost. Now, it is unfortunate that in this country electricity supply was allowed to develop on parish pump lines for so long. The result was that at hundreds of points in the country we have supplies of current at all kinds of voltages, mostly of D.C., and before installing a welder in these districts it is necessary to instal expensive converting plant which in many cases quadruples the capital outlay. Even in Birmingham to-day it is practically impossible to obtain alternating current in the central area. Fortunately, the new electricity scheme will eventually correct this, and we may look forward to a considerably increased field of application as a result. In the meantime, about three quarters of the inquiries received by makers are turned down on this account. This has been an enormous handicap to progress.

Now we come to the metallurgical difficulties. After many years of experience of welding, forging and cold working a great variety of different metals, nothing amazes me more than the cheerful reliance placed in the various British Standards Specifications. To take the mild steels alone. For our particular purpose no reliance whatever should be placed in them. They are quite useless. We have had to work out our own specifications, and our first duty after supplying the welding machines has been put to our customer in touch with steel makers who could supply suitable welding quality steel. Our standard specification for ordinary mild steel of twenty-two to twenty-four tons tensile in the annealed state is carbon .08 to .1 per cent., sulphur under .03 per cent., silicon and phos. .03 per cent. maximum manganese (not less than twenty times the sulphur content). In ten years use of this specification we have not found a single delivery not of good welding, and case-hardening quality which came within the limits of these contents, but many hundreds of tons have been rejected outside these limits but well within the ordinary British standard specifications. It has good deep drawing properties, and after case hardening had a tough non-crystalline and ductile core.

It is my firm opinion that if the British steel makers would adopt

this standard for their ordinary output of soft mild steel a great deal of their trade, lost to the Thomas quality steel on the continent, would come back to them. The most important feature of this specification is that weldability does not depend entirely upon low sulphur content but upon sulphur manganese proportionality. For instance, if the sulphur content is .025 per cent. with manganese .2 per cent. this would be a poor welding quality steel, as the manganese is less than half the required amount. If the manganese was .5 per cent. it would become a first class welding quality steel. This is one example for the need of a close study of the requirements of any particular metal to suit this process. In general, from the metallurgical standpoint, any alloy which in a plastic state allows the formation of thick grain boundaries of a weak nature cannot be welded to give a tensile strength greater than that of the grain boundaries, which may only be a quarter to half the strength of the original worked alloy.

I have given only a very rough idea of the metallurgy of this process. There is a good deal more in it than lies on the surface and a great need for research on the behaviour of metals within the narrow temperature limits of plasticity. You will begin to understand by now our other difficulty, perhaps the main one, that of obtaining sufficiently skilled superintendence effectively to control the quality of material and the keeping of the machines in proper tune, in addition to controlling correct design of the parts to be welded. The right man should have a good technical knowledge of electricity. Mechanics, metallurgy, and such men are few and far between. You will see what this means to us when I tell you that whenever we supply a plant for the manufacture of welded chain we have to spend about three months teaching the setter and operators. Fortunately, however, most of the users of welding machines require to do only a limited range of work and the makers take great care to supply the simplest of machines which are easily operated by unskilled labour.

It is this difficulty which makes some makers of welders behave in such a peculiar manner when they get an inquiry for a special machine on a job somewhat out of the ordinary. The real trouble is that they don't know how on earth the customer is going to do the job satisfactorily with the class of labour he has available. A great deal of irritation has been caused and several firms have lost thousands of pounds by supplying special machines to customers, for the sole reason that the customer had no suitable man to take charge. The only satisfactory way out of this impasse is for the machine designer and makers to undertake the more difficult and high grade welding work. After all, the makers of the machine are the logical developers of the process, and unless their machines are thoroughly tried out on long runs and a large variety of work, the possible faults and consequent improvement cannot be dis-

covered and rectified. There are many jobs being done in our own works for which we dare not sell a machine to a customer, owing to the high degree of skill required to supervise the machine on mass production. Despite our thorough methods of training it takes two or three years before a man can be put in charge of only a branch of our work, and our best men have been with us twelve years and are still learning new pointers almost every day on sample welding and experimental work.

Perhaps the most satisfactory machine in use to-day is the spot welder. This machine is mainly intended to supersede rivetting in sheet steel articles and presswork, but it is also used extensively in wire working to replace soldering. I estimate that there are over two thousand spot welders in regular use in this country to-day, covering an immense variety of products. The general range covered is from the very thin sheet of about twenty-six gauge to two pieces of three-eighths inch thick steel, and the cost of welding may be anything from twenty-five to fifty per cent. of the cost of rivetting, apart from the resulting improvement in the appearance and strength.

The principle of spot welding is that of causing a current of low voltage (from one and a half to three and a half volts) but of a large amperage to pass along stakes to water-cooled copper points. The stakes are operated mechanically to grip between the two points or tips two or more pieces of sheet metal. The current is automatically switched on and the metal immediately between the tips heats up to welding temperature, the current is switched off and the heavy upsetting pressure is applied to complete the weld. In the latest designs of spot welders the whole of these operations is automatically performed by a single stroke of the pedal, the operation taking less than a second in welding thin metal to six or eight seconds in thick mild steel.

The correct sequence of operations is of great importance in producing good welds. The setting is : grip the job firmly between the points by depressing the pedal, set the automatic switch to operate immediately after gripping, allow a fair amount of stroke on the pedal allowing the automatic switch to trip off well before the end of the stroke. The last portion of the pedal stroke then applies the heavy pressure and the weld is complete. Afterwards the operations can be repeated with accuracy by simply a single stroke of the pedal. I often see machines being operated without tripping the switch, and of course no real weld results. It is not the heat alone which makes a true weld but the heavy mechanical pressure after tripping the switch. For instance, take the case of a smith's weld. It is not by merely getting the ends of his work hot and placing them together that he can made a good joint. He has to hammer with just the correct amount of pressure to get a good weld. In a spot weld properly made the strength is greater

than the surrounding metal. This is because of the normalising effect of the rapid cooling, and in attempting to part the welded plate, the metal shears around the spot. Low-voltage welding machines are well supervised, it is possible to make sound welds continuously, and to give some idea of what can be done I have some figures of production. In our own works we have made one and one-third million welds in three-quarter inch diameter mild steel bar with less than a hundred rejects in the finished product. In this case we control the material.

In the chain making trades over a quarter of a million welds are made per week on machines of my own design, every weld of which is tested to fifty per cent. over standard Admiralty tests. In this case we indirectly control the material, the wire makers working to our specification. Of course, we cannot show these results with customers' material which does not comply with our specifications, but even when taking all classes of unknown material, rejects very rately exceed one per cent., unless the metal is very difficult. In domestic hardware, I am informed by a firm who use thirty-six machines, that rejects for bad welding are less than one-hundredth per cent., this firm making nearly two million welds per week.

The cost of current used is very small. In twenty-four gauge material either spot or butt welding in wire well over two thousand welds can be made per unit of current, and in butt welding three-quarter inch diameter mild steel about eighteen welds per unit. To give an idea of the speed of welding I have had a few Kodascope pictures made of work being done in our shops.

Discussion.

MR. W. G. GROOCOCK, President, Birmingham Section: We have been listening this evening to an expert explaining a very difficult machine, and a very difficult process. One would suggest that there are points left out which he did not consider it necessary to mention, but which you and I think ought to be mentioned, and it is in the ensuing discussion that we expect to have these brought up.

MR. F. R. NOAKE: I would like to ask Mr. Holden whether he has any information as to the life of elkonite contacts, as compared with ordinary contacts? With regard to the important point of pressure, I understand there is on the market a little pressure pad instrument by which pressure can be rapidly tested. I would also ask Mr. Holden if he can give us any actual figures about small scissors type spot welders? I have seen them at work in this country, and working very satisfactorily.

MR. HOLDEN: As regards elkonite. This is a very recent

development, and we make it our practice, whenever any new metal is put on the market, to obtain samples and test pretty thoroughly. The new elkonite is a very much harder material than copper, but its conductivity, as compared with copper, is only about one third. Now it is in some cases a very good metal to use, especially if you have got a machine well over the capacity of the work you are doing. You have to work it at higher voltage because there is rather a heavy current drop, but for heavy classes of work such as we have to deal with regularly, anything up to a quarter inch added thickness, above which you would get welds which were not very reliable, owing to the heating and the high resistance of the point of the elkonite. It has a large field, but we have, in our experiments, found there is nothing like copper, hard drawn slightly arsenical copper.

Of other metals, we have had satisfactory welds with high speed steel electrodes. We have some machines actually working on a different problem fitted with high speed tips. These are for upsetting the heads and partially welding the heads of turbine rotor blade rivets. They stick up above the side of the rotor blades about one-third of the diameter. They are placed between two electrodes in a machine fitted with very heavy upsetting power, which forces the plastic metal right down into the chamfers, and this we find also actually forms a slight weld on the face of the rotor. We were forced to use high speed steel tips in the place of copper, not from the electric conductivity point of view, but from the fact of the enormous mechanical pressure we were using, which was very often above the strength of the copper.

Some difficulty arises in copper tips, but it is not as important as one might think. It is possible, when large numbers of welds have to be made of rather a dirty material, not to use a point, but to have a dome-shaped copper tip, and with this we find we get much better welding properties than the elkonite. In cases where you have got to get into a corner, or down a groove, of course elkonite, within limits, is a very useful material, but mostly where small amounts of current are used. We tried to use a similar metal tip for rather heavy parts in steel. This was a failure, but in one way we were very successful because we actually welded the tip to the steel. Of course, this took rather a high voltage and heavy current. We tried to make an extremely rapid weld, but got a very good weld between the two different materials.

As a rule, the question of testing mechanical pressure is not important to the users of these machines because it has been considered by the makers, and the appliances by which the pressure is applied have been very carefully designed to cover the required range by slightly moving the front electrode in the top or bottom arm. A very good idea of the pressure can be obtained from the feel of the pedal. If the pedal is easily pressed down it is necessary

to use a heavier pressure, but of course, in our own experiments we do not use this method, but a rather crude device of our own for finding out the correct pressure of spring we require for any kind of work. We have as our standard a twenty-eight pound pedal pressure set to a standard distance, and we depress a cross piece fixed between the two electrodes. We work against a spring calibrated by weights until it balances and we graduate the centre bolt. In that way we can adjust pressures between two electrodes so that when the switch trips, that is the standard of pressure. It is rather remarkable what pressures are used in some machines. For instance, in the twelve-kilowatt machines, the pressure obtainable from that spring is in the neighbourhood of six hundred pounds by a pressure of twenty-eight pounds on the pedal.

We have many difficulties to overcome in marketing welding machinery. We spend a large amount of money and time in making experiments. We find that to get a good weld it is important that we should repeat, as nearly as possible, the exact pressures and voltages on every weld to obtain exactly the same satisfactory result, and we have at times been confronted with some very crude types of machines, say the German machine, in which they put the work on a large copper plate as one electrode, and carry the other electrode in the hand, then press this on the work where the spots are desired. The unfortunate thing is that it works, sometimes, but no two welds can possibly be alike. As a matter of fact, Elihu Thomson's original design was a scissors machine, but it was very inefficient. Of course there are occasions, though they are very few and far between, when there are jobs in which something of this nature has to be done—when you have got to work from the inside—but this scissors type of machine is not one that I can recommend for ordinary work.

In America the difficulty of current supply is practically non-existent. I know of machines which take two thousand kilowatts and the weld is made in three seconds. About every ten seconds the switches throw in two thousand kilowatts, and they seem to treat this with contempt, but I am engaged at present in a controversy with a large electricity supply station in the north as to whether they will allow our customer to put twenty kilowatts through on their mains at all. They consider it an unsatisfactory load. As a matter of fact, the maximum loads of a twenty kilowatt butt welder are actually much less than those due to starting a five h.p. squirrel cage motor. This type of scissors machine is required really to do metal of about one-sixteenth inch added thickness or less, and actually to do the job with a satisfactory machine would mean probably five kilowatts but the scissors machine, being very inefficient, requires a transformer of twenty-five kilowatts. That is a measure of its inefficiency and we would not be allowed to put this on the mains. I might say it is very hard

to work. A good time ago I operated this type of machine and it was far from easy to work. A good strong man is required to get decent production.

MR. J. A. HANNAY: I will take this opportunity of thanking Mr. Holden for his address. I do not know anyone who has addressed us this session who has made his points so clear. Some of us who had a few years in production and general engineering business, must hesitate when we start talking of welding. Mr. Holden started by saying how simple it was. I was wondering what he was going to tell us. I was thinking of the various times when I have seen welding done. Even when the old smith used to do it, various metals would not weld properly. Then he started to tell us of the difficulties and troubles and, finally, instead of telling us how to weld steel, he told us that steel makers did not know what they were doing. It is almost a case of the tail trying to wag the dog.

I had an experience about thirty years ago, when I was a production man in a firm who were making lifting tackle, and if anybody is going to consider welding, I think they ought to have some experience in a lifting tackle works, and then they would hesitate. Welding is all right for some simple jobs, but when anybody's life depends upon a weld being right, it is very serious. Mr. Holden had made a million welds and had only eighty failures, but if those eighty had been fatal . . . ! A year or two ago I heard Sir Herbert Austin speaking after a visit to America, and he was telling some of us how easy it was to take tubes and spot weld them. It seemed very attractive.

Training operators. I think that, with such possibilities in this method we ought to start with all the unemployed and start training them, because there are enormous possibilities.

Might I remind you that Professor Burstall, when he spoke to us in this room, told us that all this metal we were leaving on our forgings and castings was waste, and we should have to find ways of working without it. Certainly our lecturer has illustrated a way in which we can save metal. Usually, in many of our forgings and drop stampings, we have to cut away ten, twenty or thirty per cent. of the metal, and there is a great possibility of saving by welding. I was not quite clear whether Mr. Holden said he was actually making lifting chains by welding? I should not like to be underneath one.

MR. HOLDEN: Steelmaking. I have nothing to say against steel makers in this country. They actually can make the best welding quality steel, which I believe was developed by Sir Robert Hatfield, called the "Armco" quality. This steel is not made by a special process. The difference lies in the supervision of what goes into the furnace. They take good care that everything that goes into the furnace has a certain purity. Then they follow out the rest of the ordinary process and we get a metal like "Armco."

From our point of view, it is practically perfect metal. Steel makers can do these things and they will do, if they only know what is wanted, but they are being misled by the British Standard Specifications. The .05 per cent. sulphur mild steel, with .4 per cent. or less manganese, is practically a hopeless proposition for forging and welding work. It may be all right for girders or joists, but immediately you come to forge or heat it in any way, that sulphur will segregate, and one can absolutely rule out that quality of steel for strong welds.

Of course, I want you to understand this, that we are rather critical. At one time it was considered that if a weld was three quarters as strong as the solid bar it was really good work, but we are working now entirely with the intention to make a weld as strong (and in some cases we can make it stronger) than the bar, but in no case must it break in the joint. Provided the quality of steel is right, it can be done with certainty over large quantities. In steel making they have their difficulties, but we have found that we are up against steel makers on many occasions for specifications of material. We use a good many hundreds of tons of one class of metal, and we have found steel makers to work to our specifications. We find them extremely willing to oblige us, but they simply do not understand what is wanted for this process. They are misled entirely by the British Standard Specifications.

I cannot imagine a worse steel than a steel which only just complies with British Standard Specifications for forging purposes. It is being done for the chain trade. When I designed the first chain welding plant that was ever made in this country, I got beautiful results in shape and appearance, but it was rather a hopeless proposition because the steel I was working with broke at the weld, so we took the trouble to get a great many varieties of steel, and I found at that time (this was in the early days of the war) we had a very good steel from America. One specification in particular was the ordinary mild steel wire as manufactured in America. We found it of excellent welding quality. We had four or five firms of wire drawers who are working to that specification, supplying steel to the chain trades, and for the last three years I have not heard of them getting any rejected for that purpose.

The chain trade has progressed enormously, especially at the latter end of the war. I do not know if any of you remember the great North Sea mine fields across from Norway. These mines were designed and fitted with sinkers which were suspended one under another with different weights, by means of a length of chain at, I think, ten feet, dropping to seven feet, and then the bottom sinker five feet. They ordered the very best quality hand made iron chain. They got it, but the rough seas were lashing the sinkers about so that the chains were breaking and dropping to the bottom. The Admiralty, who had previously rejected elec-

trically welded chain, sent out specifications in which all chain makers had to supply a piece of chain of their manufacture which would stand fifty per cent. over Admiralty test. The only people who could make this chain were electrical welding people, and over four hundred tons of that material were supplied. I might mention that it was No. 4 chain, and every inch had to be tested by twenty-five cwt., and the whole thing was put into action and worked perfectly. Now, when the Admiralty want especially strong chain, they specify electrically welded. Lifting chain is not used to any great extent in the class of appliance that is used in this country except in blocks up to one ton. The limit of present day block chain making is about three-eighths inch diameter. It is almost universal on the Weston type blocks.

MR. E. J. WILEY: Weld testing, of course, is very important. There has always been suspicion about welds, ever since there have been welds. It seems to me, when you come to think of the possible variations that may exist after you have set the machine and calibrated the spring, you are still in the hands of the operator to some extent. If he puts the ends of the bars close together there is a different pressure than if they hardly touch. If a weld is going to last you can be quite sure you must test the piece, not only the weld, before you can place it in a job where, perhaps, life depends upon it. If it stands the tests, there should be no difficulty about using electrical welding, particularly when one views it from the point of view of cost saving.

A VISITOR asked about the necessity of cleanness of surface to be welded from scale and oil.

MR. R. H. YOUNGASH: I was interested in Mr. Holden's remarks on the metallurgical aspects of this job, because there is no doubt of the truth of what he says. However, equally there is no reason for doubting that steel makers can give us steel which would be quite effective from the user's point of view but for the abominable sulphur content which causes trouble. With regard to welded chains. Mr. Hannay would not like to stand under one. Of course, he would have no business to stand under any kind of chain. When you consider how chains were made in the Black Country a few years ago, I feel sure that properly electrically welded chains are superior, and there must be many miles of electrically welded chains where people do not know that it is electrically welded. When you speak of such a particularly low voltage as one and a half to three, does the voltage control, or does the amperage control the temperature which the piece reaches before the weld takes place? I should like to hear Mr. Holden say something about the quasi-arc method of welding.

MR. HOLDEN: With regard to testing, of course it is a very important feature. There are a good many classes of welds which ought to be tested, and it is a practice of several good welders to

arrange for this testing, sometimes in the process of welding. There is a very easy test, for instance, on welding an article like a motor car brake cam. We weld this concentric, but bent, so that the bar has to be struck with a hammer and straightened to make it run true. Then the burr is smoothed off, but a very sharp blow with the hammer while it is between two centres is a very good test of this weld. The man using the hammer can tell by the rebound he gets from the hammer; if there is the slightest weakness the hammer will not rebound but sag and remain dead. Although we have found that is enough, to ensure concentricity, we can arrange it so that we shall weld slightly on one side, and then we straighten and in that way the weld is tested. That, of course, is applied to each piece, and in that particular class of work is very satisfactory, but you cannot do the same thing with a very thin job like a brake rod. These are tested in semi-automatic testing machines which slightly stretch the rod. An experienced man can tell bad welds by the appearance of the extrusion.

Now, it is very fortunate that one of the best methods of testing a metal is by examining the weld burr. If the sulphur is in excess, it segregates in lines and when we push the metal together it is not ductile and soft along the segregation, and we find the weld in the test splits at the elongated segregation. Immediately that happens in practice, that quality of steel will be stopped. Sometimes we get excess of phosphorus, which fortunately for us, has another characteristic. When it becomes plastic, we find that the endways pressure is not transmitted through the plastic metal to the outside edge, so that instead of getting a closed joint we get a vee around it. When we get a circular groove, we know that phosphorus is the trouble, and that will not be a safe weld. Of course, we recommend continuous testing. If anything is doubtful, test it.

About cleanliness. This is essential for good welding. We reckon to weld steel, not oxide, and of course we are faced sometimes with very heavily scaled material, some purposely scaly, such as planished steel, which is covered with blue oxide, and is practically like a piece of pot on the surface. Before you can get a weld, you have to burn it off, and you get enormous flashes and sparks in so doing. Our view is that if you want to make a really good weld, you must have clean material. Oxide, whether red or blue, has absolutely no business in a weld at all, though very fortunately, there is a kind of explosive effect. If this burning away is followed with a double weld, we get a good result, but it is not the right thing for good work. In the holloware trade all metal is scaled before welding. We made some tests by allowing the pieces to become blue on the end—heating them and pressing together—parting them, and found the oxide had all gone leaving the clean faces. Though, of course, it is possible to do a certain class of welding with a light scale, everything depends on the thickness of the scale. If it is

only a very light scale, it is very easily dissipated. Thick scale, if it is red or blue, must be exploded or burnt away.

Voltage, of course, is rather an empirical question. One reason why we consider the English machines better than the American spot welders is that they work definitely at a low voltage. That is a measure of the efficiency of the machine. The voltage does not always reach the maximum point, there is a drop. You have got to build a machine and work out the voltage drop and then correct the design again. The regulation of this machine is within two or three per cent. in the machine itself which, of course, is very good when you consider the main supply itself is subject to variations of from five to ten per cent. If you use a heavy pressure you will require a larger voltage owing to the lower resistance of the joint. For instance, a weld of three inches square in a butt welder used a voltage of only three and seven-eighths. If we go to four for this we run a risk of burning. That low voltage is a measure of efficiency, if the speed of welding is the same because it denotes a low voltage drop.

Quasi-arc welding has a large field, but it is outside the scope of the present lecture. We do not pretend to say low-voltage welding is better than any other form of weld. Each form of welding has a definite field, and in the case of trying to supplant rivetting, part of that field can be absorbed by the low voltage process in the thinner materials, but on the thicker metals, such as used on constructional work, there is not the slightest doubt that arc welding is the correct process. Gas welding has also a definite field. It is surprising really, how little we overlap. There are very few things which are usually gas or arc welded which can be done by our process. Of course, this low-voltage welding is the only true autogeneous process, in which heat is generated inside the material itself, but arc fusion welding is not the same as low-voltage welding, because it lacks the pressing together to form a true weld, which pressure corresponds to the working and hammering of the smith in ordinary welding.

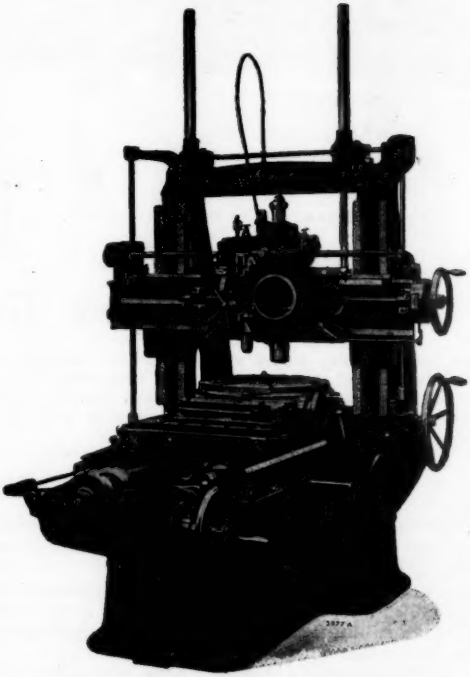
MR. E. W. FIELD proposed a vote of thanks to Mr. Holden, and the meeting closed.

ESTD. 1861.

SIP

11 HIGHEST AWARDS

SOCIÉTÉ GENEVOISE D'INSTRUMENTS DE PHYSIQUE

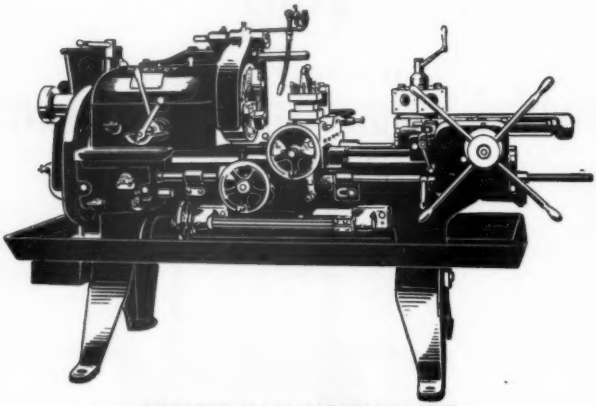


New Model No. 5B *Jig Boring Machine.*
Increased Boring Capacity, Rigidity, Efficiency.
Write for descriptive catalogue to

SOCIÉTÉ GENEVOISE, LTD.
95, Queen Victoria St., London, E.C.4

Please mention this Journal to Advertisers.

HERBERT



HERBERT No. 5A CAPSTAN LATHE.

New Developments in Machine Tools

We have recently placed on the market a number of new machines of entirely new design. They have proved themselves to be far superior in output, rigidity, operation and durability than any other machines of their type hitherto made.

THE NEW MACHINES ARE:

No. 5A Capstan Lathe with patent covered slides and improved chasing saddle 1⅝″ x 9″.

No. 5B Capstan Lathe with patent covered slides, with automatic sliding and surfacing saddle instead of chasing saddle, 1⅝″ x 9″.

No. 6 Combination Turret Lathe with patent covered bed, 15″ swing.

No. 10 Combination Turret Lathe with patent covered bed and roller bearing spindle, 20½″ swing.

No. 24 Combination Turret Lathe with patent covered bed, Anti-friction bearings to single pulley and all shafts, 33″ swing.

No. 33 Plain Milling Machine with roller bearing spindle and ball or roller bearings to single pulley and all shafts, 21″ x 6″ x 16″.

No. 48V High Power Vertical Milling Machine, 72″ x 33″ x 28½″.

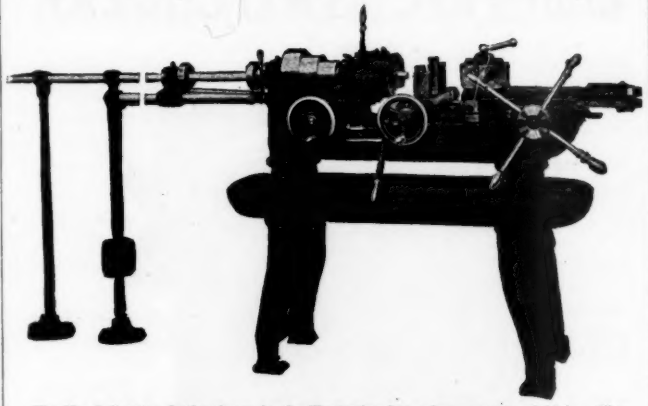
These machines may be seen in operation in our works at Coventry.

ALFRED HERBERT LTD. COVENTRY

Please mention this Journal to Advertisers.

Ward

UNGEARED CAPSTAN LATHES



The No. 2 Capstan Lathe shown in the illustration has a bar capacity of 1¼-in. The capstan slide has a working stroke of 5½-in., and can be fitted with automatic feed, if required.

The Ward range contains four sizes of Ungeared Capstan Lathes, Nos. 0, 1, 2 and 3, with 4-in., 5-in., 5½-in. and 6½-in. height of centre respectively.

Used in conjunction with the Automatic Chuck these machines are primarily intended for the production of components from bar, but when fitted with self-centring chucks and face-plates they are capable of a great variety of work in the form of castings, forgings and stampings, although it is often possible to utilise the Automatic Chuck for hot brass stampings and die castings.

Delivery from Stock.

H. W. WARD & Co. Ltd.

SELLY OAK : : : : : BIRMINGHAM

ELLISON
ELECTRIC SWITCHGEAR

Ellison Electric Switchgear is used for controlling the machinery of all kinds of industries. It is safe to handle, gives simple, direct control, and is easy to maintain.
You can equip the largest factory throughout with Ellison Switchgear, from the 11,000 volt incoming supply through metal-clad switchboards to the controlling devices for the motors.
The illustration shows a small Ellison Circuit Breaker of the type preferred in factories, mills and works, where workmen, without electrical knowledge, start and stop their own machines.

Write for Booklet: **"ELECTRIC MOTORS AND CONTROL SWITCHGEAR."**

GEORGE ELLISON
LIMITED

PERRY BARR **BIRMINGHAM**

TRADE MARK

RIFLE & REVOLVER MANUFACTURE

Many Interesting Problems at the

Royal Small Arms Factory, Enfield.

By special permission of the WAR OFFICE, readers of "MACHINERY" are to be given the exclusive privilege of studying modern methods of rifle and revolver manufacture.

At the Royal Small Arms Factory, Enfield, there is much to interest all executive engineers. The unique system of planning for instance, so arranged to facilitate an immediate increase to big scale production at any time.

Most components are machined from solid forgings, which involves many intricate and interesting machining operations. On the rifle body no less than 197 different operations are required, and 61 to complete the barrel alone. All operations are performed to close limits under a system developed from long and intimate experience.

The above points will all be covered by "MACHINERY'S" articles. Illustrations and drawings of equipment including jigs, fixtures and tools, will add to the interest, and there will be much valuable information on gun browning, oil blacking, copper soldering, heat treatment, finishing and polishing operations on woodwork, etc.

The first article will appear in "MACHINERY'S" March quarterly number. DON'T MISS IT. Sign, tear off and post the attached coupon to-day.

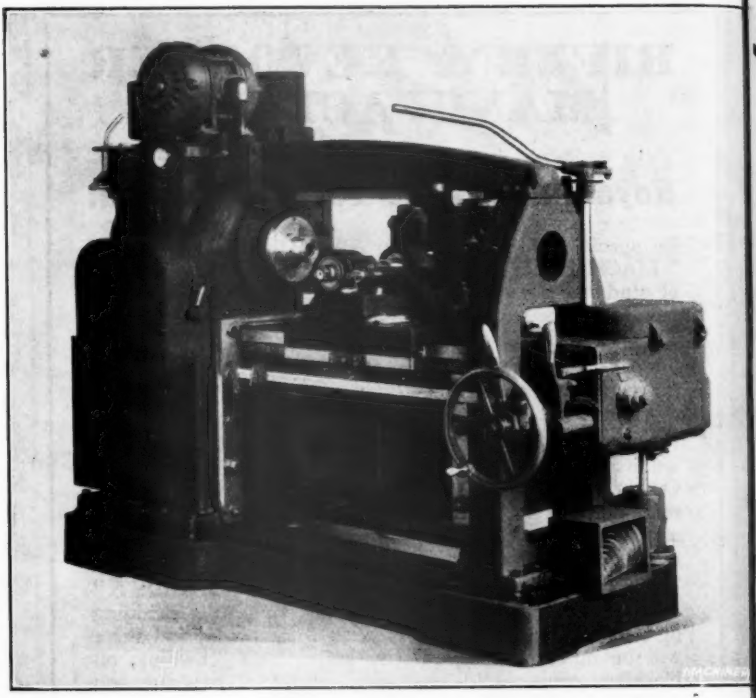
TO MACHINERY, 52-54, High Holborn, London, W.C.1.

Please enter my subscription to MACHINERY for one year commencing with the March Quarterly Number at the rate of 25/-, payable by monthly instalments of 2/1. Overseas orders 34/-, cash with order.

Name.....

Address.....

Firm.....



BARBER – COLMAN

Model "B" Production Hobbing Machine

Designed for high production and accuracy. Direct connected Motor Drive, centralized interlocking controls, hob slide power rapid traverse, and several other features about which we should like to tell you.

Please write for particulars to :—

BARBER & COLMAN, Ltd.

BROOKLANDS, near MANCHESTER.

Telegrams—"BARCOL, SALE." **Telephone—SALE 496 and 7**

Please mention this Journal to Advertisers.

RAISE YOUR STEAM by OIL-FIRED VERTICAL BOILERS

FIT your boilers as illustrated with a Parwinac Industrial Oil Burner and weigh up some of the advantages:—

Immediate starting up.

Steam pressure raised in half the time taken by solid fuel.

Fuel easily and cleanly handled.

Pressure constant throughout sudden load changes.

Beautiful flexibility in carrying peak and valley loads.

Clean boiler house. No ash to dispose of.

We shall be glad to send Booklet IND 698 and full particulars of the "Parwinac" to all interested.

Write to-day.

PARKER, WINDER AND ACHURCH LTD., Heating Engineers, BIRMINGHAM

London: 4, *Gt. Marlboro' Street, W.*1.
Manchester: 16, *John Dalton Street.*
Leicester: 64, *London Road.*

See this Burner at STAND 89, Ground Floor, Grand Hall, Heating and Lighting Section, IDEAL HOME EXHIBITION.

Parwinac Burner fitted to boiler in a Birmingham Factory.

PARWINAC INDUSTRIAL OIL BURNER

OBA9

"Corona" Machine Tool Works, Leicester

(THE HOME OF THE DRILLING MACHINE)

Fredk. Pollard & Co. Ltd. have two No. 5 Société Genevoise Jig Boring Machines which are not at present fully employed on their own productions. They are open for a limited amount of outside **JIG BORING.**

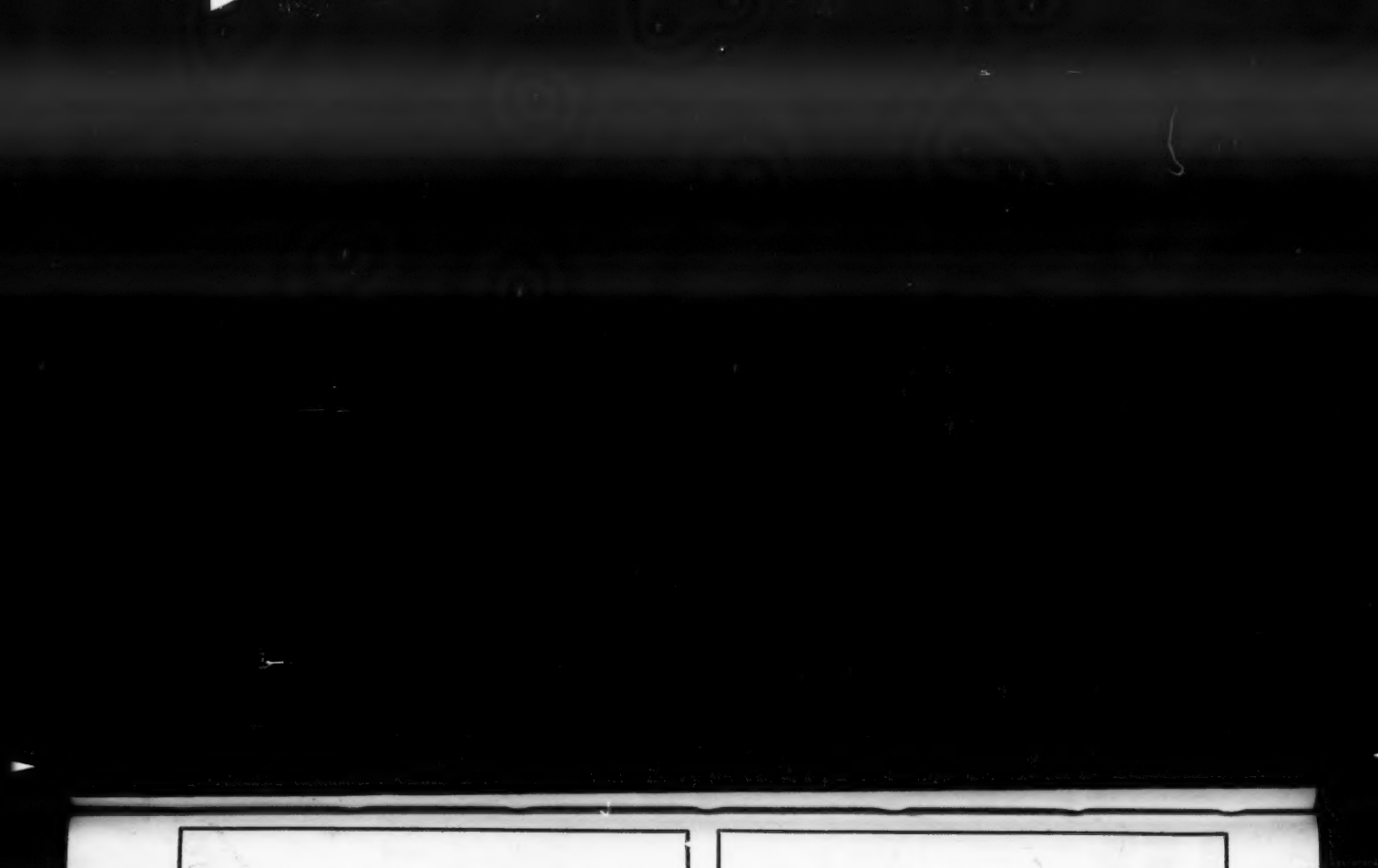
Price quoted against drawings.

Telegrams: "Corona," Leicester. 'Phone: 27534—27535.

Advertisement Rates

for the Journal can be obtained on application to the Head Office of the Institution,

40, GREAT JAMES STREET
Bedford Row, LONDON, W.C.1.

'Phone: HOLBORN 7510.

Please mention this Journal to Advertisers.